A.D. 1869, 10*th* MAY. N° 1434.

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Treating Crude Iron, &c.

LETTERS PATENT to Henry Bessemer, of Queen Street Place, Cannon Street, in the City of London, for the Invention of "IMPROVEMENTS IN THE TREATMENT OF CRUDE OR PIG IRON AND OTHER CARBURETS OF IRON, AND IN THE APPARATUS EMPLOYED FOR SUCH PURPOSES."

Sealed the 6th July 1869, and dated the 10th May 1869.

PROVISIONAL SPECIFICATION left by the said Henry Bessemer at the Office of the Commissioners of Patents, with his Petition, on the 10th May 1869.

I, HENRY BESSEMER, of Queen Street Place, Cannon Street, in the City of London, do hereby declare the nature of the said Invention for "IMPROVEMENTS IN THE TREATMENT OF CRUDE OR PIG IRON AND OTHER CARBURETS OF IRON, AND IN THE APPARATUS EMPLOYED FOR SUCH PURPOSES," to be as follows:—

My Invention consists of a method or methods of carburizing a further carburizing molten pig iron after it leaves the blast furnace and prior to its solidification, and also the further carburation of molten scrap or other wrought or malleable or puddled iron or steel that has been fused in high-pressure furnaces (as described in the Specification

of a Patent granted to me on the 10th day of November 1868, and numbered 3419) or by other means, and which treatment may also be made to in part purify the iron of sulphur or other deleterious matters simultaneously with the carburizing process.

In carrying my Invention into practical operation I construct a vessel of plate iron, which I line with fire-bricks or other refractory slow conductor of heat. I make the vessel by preference in the form of an upright cylinder. The interior of the lining may be made more or less in the shape of an inverted air balloon; the lining may be from one and a half feet to two feet in thickness, and of an internal capacity by preference of 100 cubic feet at the least. I mount this vessel on the table of a hydrostatic ram or plunger having a range about equal to the external height of the vessel, at the upper part of which I make an opening, say of one foot in diameter, and at the lower part I form a tap hole similar to the tap holes of cupola melting furnaces. I also provide other openings for the insertion of tuyeres, so that the vessel may be filled with coke, and the fire urged until the whole mass of the fuel is brought into a state of vivid ignition and the massive lining of the vessel heated more or less throughout. I also make a sort of shallow pit at a convenient distance from the blast furnace, and I fit the hydrostatic apparatus into this pit in such a manner that when the ram sinks down with the vessel the upper part of the latter will be in such a position that a stream of fluid iron from the blast furnace may by means of a gutter be run therein, the stroke of the ram being such that on the rising up of the vessel the tap hole situated in the lower part of the vessel will rise high enough to allow the metal to be run from it into the "pig bed" as usual. The blast pipes may be made to slide telescopically so as to admit of this motion. The rising and lowering of the ram may be effected by suitable pumps arranged in a similar manner to that adopted for the rising and lowering of the casting crane used in the Bessemer process, or a single hand pump may be employed to raise the vessel.

The apparatus so constructed and arranged is for the purpose of carburizing or further carburizing the molten metal run therein. For this purpose the vessel must be brought up to a high temperature by the blast. I prefer that the coke or other carbonaceous fuel employed should entirely fill the whole vessel excepting the spaces between the lumps of fuel. When the vessel has been thoroughly

heated, the tuyere holes having been stopped in the same way as the tap hole, the fluid iron may be run from the blast furnace into this vessel amongst the coke; a fire-tile stopper and some sand is then made to fill entirely the mouth of the vessel, and thus retain the heat of the metal as much as possible. The iron being thus brought in close contact with a large surface of incandescent carbon will absorb a further quantity (unless previously saturated), depending upon the temperature of the metal and fuel, on its previous state of carburation, and on the length of time to which the molten iron is subjected to the action of the incandescent carbon. Two such carburizing vessels may be employed near each other, so as to admit of one being under repair while the other is employed. Where the level of the ground admits of it the vessel need not be made moveable, the pig bed being in that case at a level low enough to allow the carburized iron to be run into it; and although I have described a means by which this vessel may be lowered and raised by hydrostatic pressure on the ram to which it is attached, I in some cases use in lieu thereof a screw or rack, and thus rise or lower the vessel by means of engine power transmitted through gearing of the usual kind.

When it is desired to highly carburize pig iron containing only a small quantity of carbon, or when refined or finery iron is to be recarburized, or when molten, wrought, or other malleable or scrap iron and steel or other carburets of iron require to be further carburized, I prefer to heat the carburizing vessel to an extremely high degree of temperature by nearly closing the mouth of the carburizing vessel during the time of forcing in the blast, whereby I am unable to retain the products of combustion under pressure, as in the furnaces described in a Patent granted to me, and bearing date the 10th day of November 1868, and numbered 3419. The interior of the vessel and the carbon it contains will be thus highly heated, the metal will in consequence absorb or take up carbon more rapidly, and may then be run off and used for either of the several purposes for which it is thus rendered especially suitable. The hæmatite pig iron of the higher numbers, such as numbers 2, 3, and 4, usually made with a pure and expensive coke may be thus further carburized and rendered more suitable for conversion into steel by the Bessemer process. A less quantity of coke may be used in the blast furnace when this after process of carburation is employed and at the same time a more uniform quality of metal will be obtained. Coke, anthracite coal,

charcoal, partially charred wood, or other pure fuels may be employed, and before running the metal into the carburizing vessel carbonate of soda, chloride of sodium, chloride of calcium, lime, or other matters known to act as purifiers of molten iron may be put into the vessel for the purpose of in part purifying the metal during the carburizing process, and with the same object the coke or other fuel may be specially prepared.

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said Henry Bessemer in the Great Seal Patent Office on the 10th November 1869.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, HENRY BESSEMER, of Queen Street Place, Cannon Street, in the City of London, send greeting.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Tenth day of May, in the year of our Lord One thousand eight hundred and sixty-nine, in the thirty-second year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Henry Bessemer, Her special licence that I, the said Henry Bessemer, my executors, administrators, and assigns, or such others as I, the said Henry Bessemer, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "IMPROVEMENTS IN THE TREATMENT OF CRUDE OR PIG IRON AND OTHER CARBURETS OF IRON, AND IN THE APPARATUS EMPLOYED FOR SUCH PURPOSES," upon the condition (amongst others) that I, the said Henry Bessemer, my executors or administrators, by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that I, the said Henry Bessemer, do hereby declare the nature of the said Invention, and in what manner the same is to be

performed, to be particularly described and ascertained in and by the following statement thereof, that is to say :—

My Invention consists of a method or methods of carburizing or further carburizing molten pig iron after it leaves the blast furnace and prior to its solidification, and also the further carburation of molten scrap or other wrought or malleable or puddled iron or steel that has been fused in high-pressure furnaces (as described in the Specification of a Patent granted to me on the 10th day of November 1868, and Number 3419) or by other means, and which treatment may also be made to in part purify the iron of sulphur or other deleterious matters simultaneously with the carburizing process.

In carrying my Invention into practical operation I construct a vessel of plate iron, which I line with fire-bricks or other refractory slow conductor of heat. I make the vessel by preference in the form of an upright cylinder. The interior of the lining may be made more or less in the shape of an inverted air balloon; the lining may be from one and half feet to two feet in thickness, and of an internal capacity by preference of 100 cubic feet at the least. I mount this vessel on the table of a hydrostatic ram or plunger having a range about equal to the external height of the vessel, at the upper part of which I make an opening say, of one foot in diameter, and at the lower part I form a tap hole similar to the tap holes of cupola melting furnaces. I also provide other openings for the insertion of tuyeres, so that the vessel may be filled with coke or other fuel, and the fire urged by a blast of air through these tuyeres until the whole mass of the fuel is brought into a state of vivid ignition and the massive lining of the vessel intensely heated on its interior surface, and more or less throughout its entire thickness. I also make a sort of shallow pit at a convenient distance from the blast furnace, and I fit the hydrostatic apparatus into this pit in such a manner that when the ram sinks down with the vessel the upper part of the latter will be in such a position that a stream of fluid iron from the blast furnace may by means of a gutter be run therein, the stroke of the ram being such that on the rising up of the vessel the tap hole situated in the lower part of the vessel will rise high enough to allow the metal to be run from it into the "pig bed," as usual. The blast pipes may be made to slide telescopically so as to admit of this motion. The rising and lowering of the ram may be effected by suitable pumps arranged in a similar manner to that adopted for the rising and

lowering of the casting crane used in the Bessemer process, or a single hand pump may be employed to raise the vessel.

And in order that the construction and mode of working such apparatus for carburizing or further carburizing molten iron may be fully understood, I have hereunto annexed a sheet of Drawings on which an apparatus suitable for this purpose is shown in vertical section at Figure 1, in elevation and by dots in Figure 2, and in horizontal section at Figure 3, in each of which Figures the same letters of reference are used to indicate each particular part where it is repeated.

a represents the outer metal shell of the carburizing vessel formed of stout rivetted plate iron lined internally with fire-bricks, ganister, or other suitable slow conductor of heat, as shewn at *b*, the lining being of considerable thickness in order the better to retain the heat of the metal under operation for several hours; *c* is the table of a hydraulic ram *d*, which passes through a stuffing box or leather ring at *e* for the purpose of keeping a water-tight joint, as is well understood; *f* is a large flanged plate formed at the upper part of a hydraulic cylinder f^*, shewn broken off, and into which cylinder the ram *d* works freely, rising by the pressure of water within the cylinder f^*, and sinking down by its own gravity whenever the water is allowed to flow out by a valve under the control of the workman. The flanged plate *f* is supported on masonry forming the bottom of a pit or well *r* into which the vessel may be lowered, as shown in Figure 2. The vessel is provided with a tapping hole *g* and spout *h* through which the metal is drawn off at the end of the process, falling into the gutter *s*, by which it is conveyed to the pig bed or where else it may be required; there are also two similar openings *i*, *i*, (best seen in Figure 3) into which the nozzles *m* of the blast pipes m^1 are inserted. The blast pipes m^1 are moveable in stuffing boxes m^2 formed on short pieces of pipe attached by flanges to the vessel *a*. The upper end of the blast pipe m^3 is provided with branches m^4 which communicate with the stuffing boxes m^2 and pipes m^1, which are free to swing round in the stuffing boxes m^2, as shown by dots, and be thus withdrawn from the openings *i*, *i*, in order that these openings may be closed with a plug of loam in a similar manner to the closing up of the tap holes of ordinary cupola furnaces. In order to admit of the motion of the vessel *a* upwards and downwards the pipe m^3 is made to slide through a stuffing box m^5 formed at the upper end of the main blast

pipe m^6, which is of sufficient internal diameter and length to receive the pipe m^3 when the vessel a is lowered.

When such an apparatus is employed to further carburize the molten iron from the blast furnace, or to carburize re-melted pig iron from a cupola or other melting furnace, a fire is first made in the interior of the vessel for several hours, a powerful blast of air through the nozzles being employed to bring the whole body of coke or other fuel into a state of intense combustion, the vessel being filled as completely with fuel as possible, excepting the spaces necessarily left between the lumps or pieces of fuel. The nozzles are then withdrawn and the holes i, i, closed with loam. The tap hole, which during the heating up of the vessel serves as an escape for any slags that are formed, is also securely closed; a gutter n is then moved over the mouth of the vessel, as shewn in Figure 2, and as much fluid iron is run in as will fill up all the interstices left between the lumps of fuel; a fire-tile p is then covered over the mouth of the vessel, and some sand thrown around the joint to prevent as far as possible the escape of heat. When a full cast from the blast furnace of about 12 to 16 tons is so enclosed within the highly heated vessel it will retain its fluidity for eight or ten hours, and may then be discharged from the vessel by simply rising the ram d and vessel a into the position shown in Figure 1 and opening the tap hole g, which will allow the carburized metal to flow into the gutter s, and from thence into the pig bed, or into the Bessemer converter if intended for direct conversion into malleable iron or steel. It will be understood that the exclusion of atmospheric air during this process of fluid cementation prevents the loss or destruction of the fuel, except so much thereof as is absorbed or taken up by the iron, so that the renewal of a small quantity of coke or other fuel and a few minutes use of the blast will restore the conditions necessary for a repetition of the process, which by preference should follow at a short period after the discharge of the carburized metal. The iron having been thus brought in close contact with a large surface of incandescent carbon will have absorbed a further quantity (unless previously saturated), depending on the temperature of the metal and fuel on its previous state of carburation, and on the length of time to which the molten iron is subjected to the action of the incandescent fuel. Two such carburizing vessels may be employed near each other, so as to admit of one being under repair while the other is employed. Where the level of the ground admits of it the vessel need not be made moveable, the pig bed being

in that case at a level low enough to allow the carburized iron to be run into it; and although I have described a means by which this vessel may be lowered and raised by hydrostatic pressure on the ram to which it is attached, I in some cases use in lieu thereof a screw or rack, and thus rise or lower the vessel by means of engine power transmitted through gearing of the usual kind.

When it is desired to highly carburize pig iron containing only a small quantity of carbon, or when refined or finery iron is to be re-carburized or when molten, wrought, or other malleable or scrap iron and steel or other carburets of iron require to be further carburized, I prefer to heat the carburizing vessel to an extremely high degree of temperature by nearly closing the mouth of the carburizing vessel during the time of forcing in the blast, whereby I am enabled to retain the products of combustion under pressure, as in the furnaces described in a Patent granted to me and bearing date the 10th day of November 1868, and numbered 3419, the interior of the vessel and the carbon it contains will be thus highly heated, the metal will in consequence absorb or take up carbon more rapidly, and may then be run off and used for conversion into malleable iron or steel, or be used for either of the several purposes for which it is thus rendered especially suitable. The hematite pig iron of the higher numbers, such as numbers 2, 3, and 4, usually made with a pure and expensive coke, may be thus further carburized and rendered more suitable for conversion into steel by the Bessemer process. A less quantity of coke may be used in the blast furnace when this after process of carburation is employed, and at the same time a more uniform quality of metal will be obtained by the treatment of a whole cast or charge from the blast furnace by which all the metal will be of one number or quality. Coke, anthracite coal, charcoal, partially charred wood, or other pure fuels may be employed, and before running the metal into the carburizing vessel carbonate of soda, chloride of sodium, chloride of calcium, lime, or other matters known to act as purifiers of molten iron may be put into the vessel along with the fuel, or prior to the running in of the fluid iron, and in such quantities as may be in practice found advantageous according to the quality and quantity of metal treated for the purpose of in part purifying the metal during the carburizing process, and with the same object the coke may if desired be specially prepared by the abstraction of sulphur therefrom by any known means.

Having thus described my Invention, and the manner in which the same may be carried into practical operation, what I claim is,—

Firstly. I claim the carburation or further carburation of molten pig iron after it leaves the blast furnace and prior to its solidification by subjecting such iron in close vessels or chambers to the action of incandescent carbon or carbonaceous matters the combustion of which is not kept up by a supply of oxygen.

Secondly. I claim the carburation or further carburation of remelted pig iron, and of molten malleable iron and steel, and of refined or finery iron, by subjecting such iron in close vessels or chambers to the action of incandescent carbon or carbonaceous matters the combustion of which is not kept up by a supply of oxygen.

Thirdly. I claim the combined process of further carburating molten carburets of iron by subjecting such iron in close vessels or chambers to the action of incandescent carbon or carbonaceous matters, the combustion of which is not kept up by a supply of oxygen, and the conversion of such carburized iron into malleable iron or into steel by the action thereon of atmospheric air as in the "Bessemer process."

Fourthly. I claim the simultaneous carburation and partial purification of molten iron by the means and in the manner substantially as herein described.

Fifthly. I claim the general form and arrangement of apparatus for carburizing or further carburizing molten iron, substantially as herein described.

In witness whereof, I, the said Henry Bessemer, have hereunto set my hand and seal, this Tenth day of November, in the year of our Lord One thousand eight hundred and sixty-nine.

HENRY BESSEMER. (L.S.)

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BESSEMER'S Specification.

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FIG. 1.

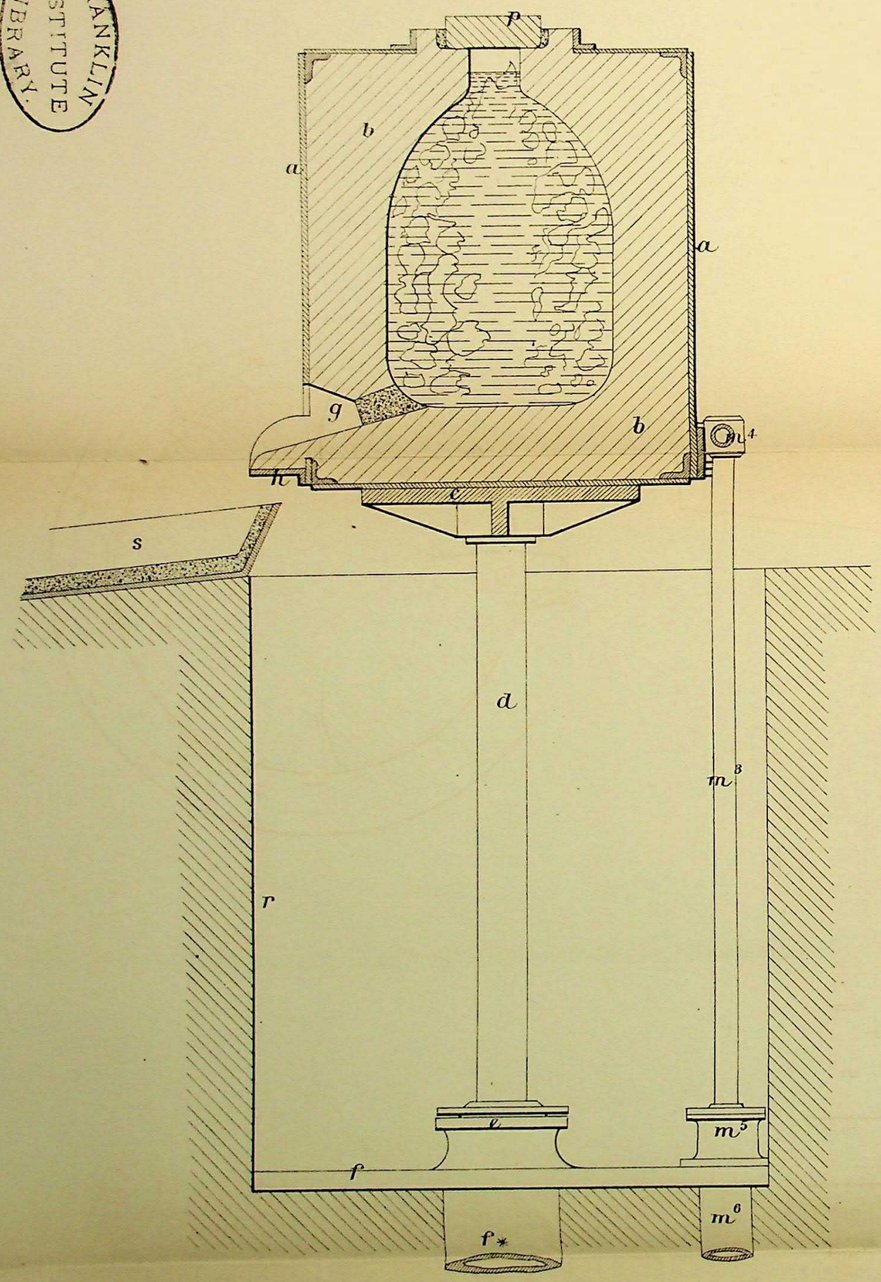


FIG. 2.

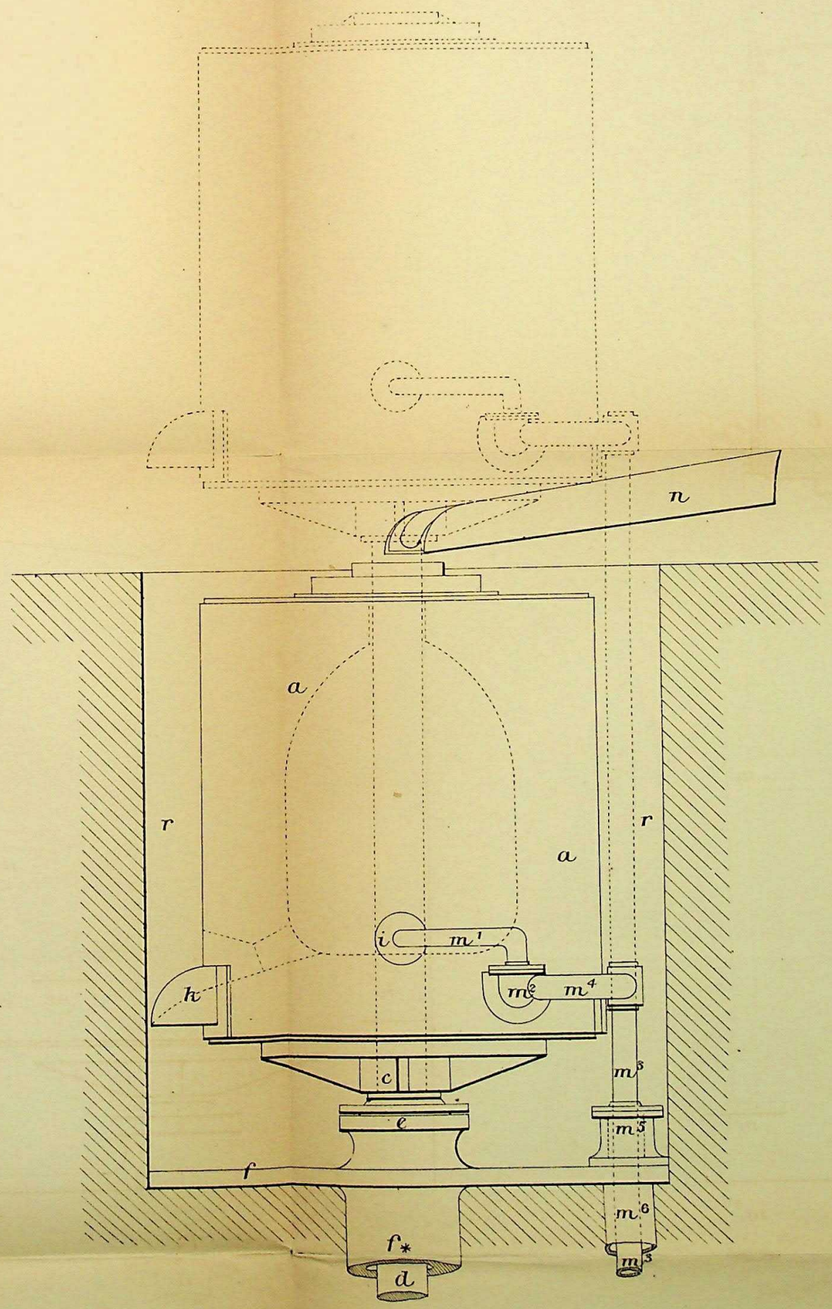
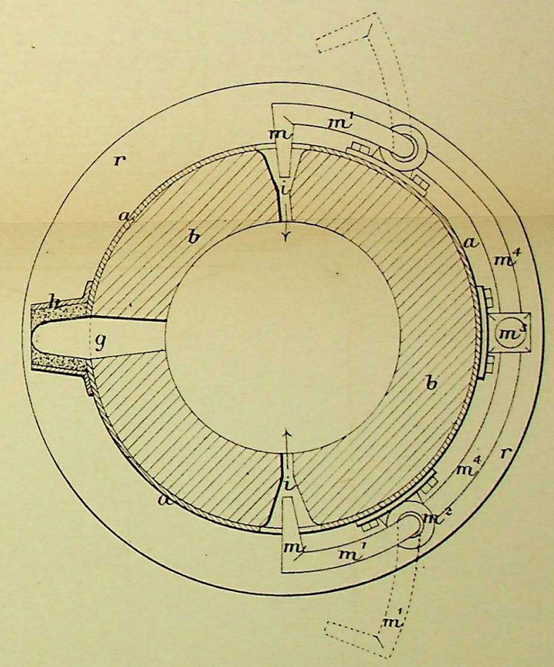


FIG. 3.



The filed drawing is not colored.

Drawn on Stone by Malby & Son

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